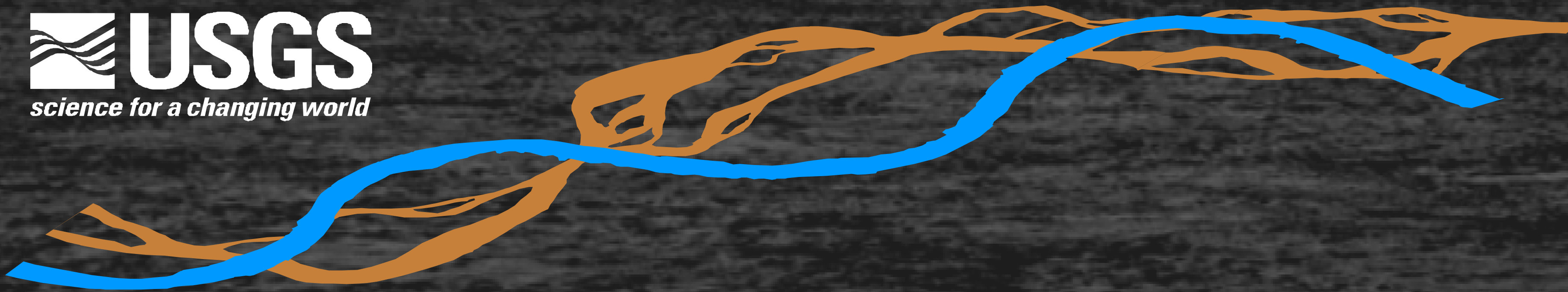

Process and Prospects for the Designed Hydrograph, Lower Missouri River

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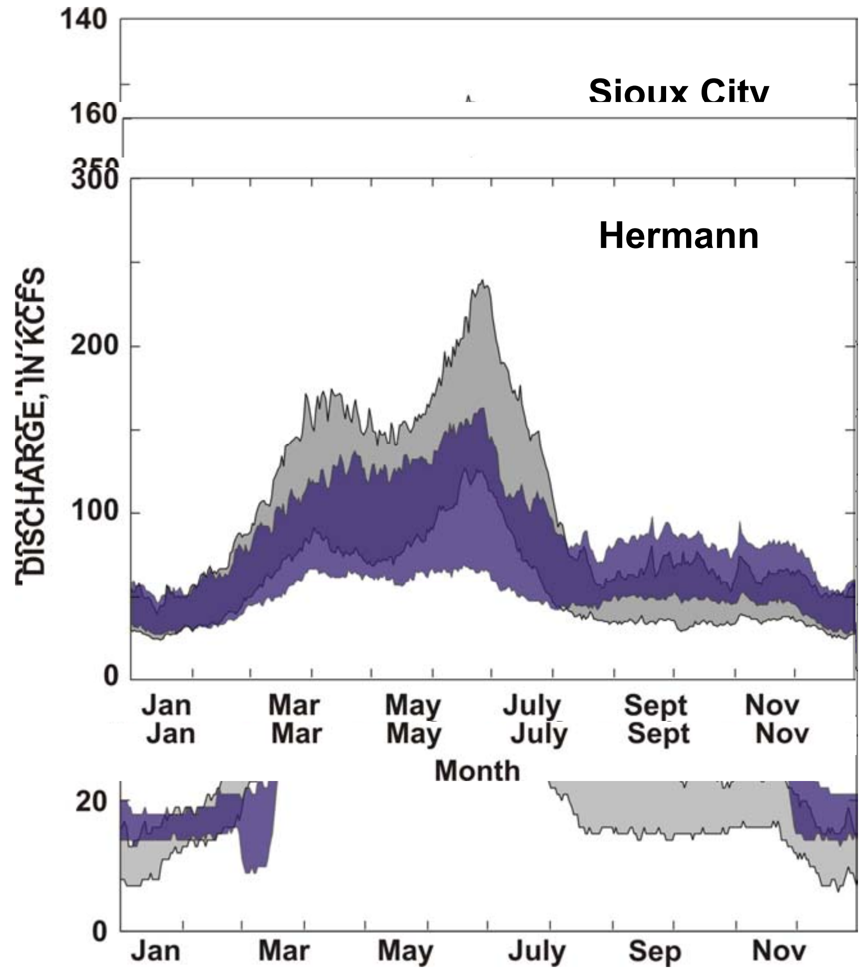
Lower Missouri Flow-Regime Gradient



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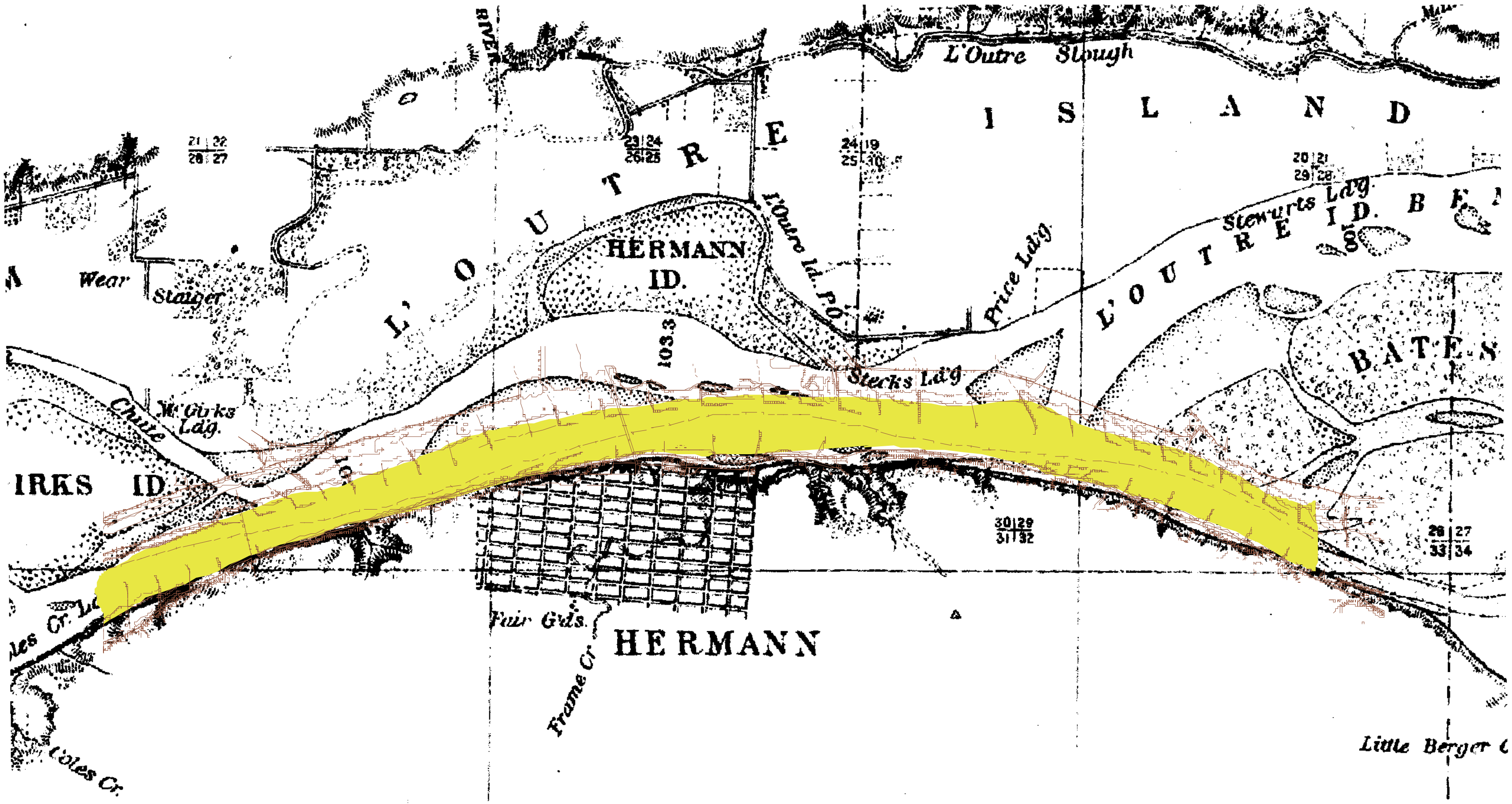
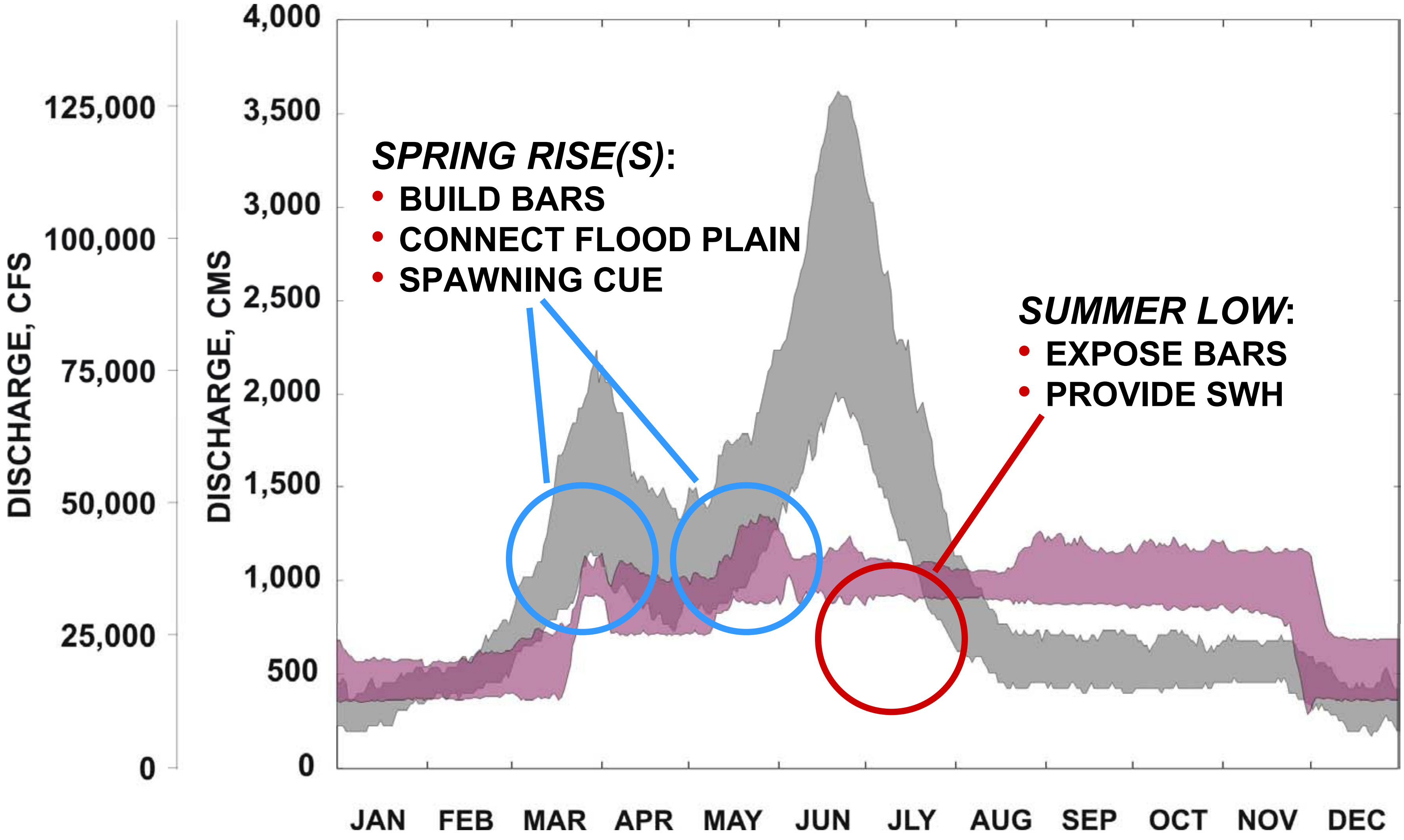
Changes in Channel Form

- *Historical reference conditions*



Lower Missouri Flow-Regime



Functions of the Hydrograph

Summer Low

Hypothesized Role
Expose sand bars
Provide shallow-water habitat for young fish

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Functions of the Hydrograph

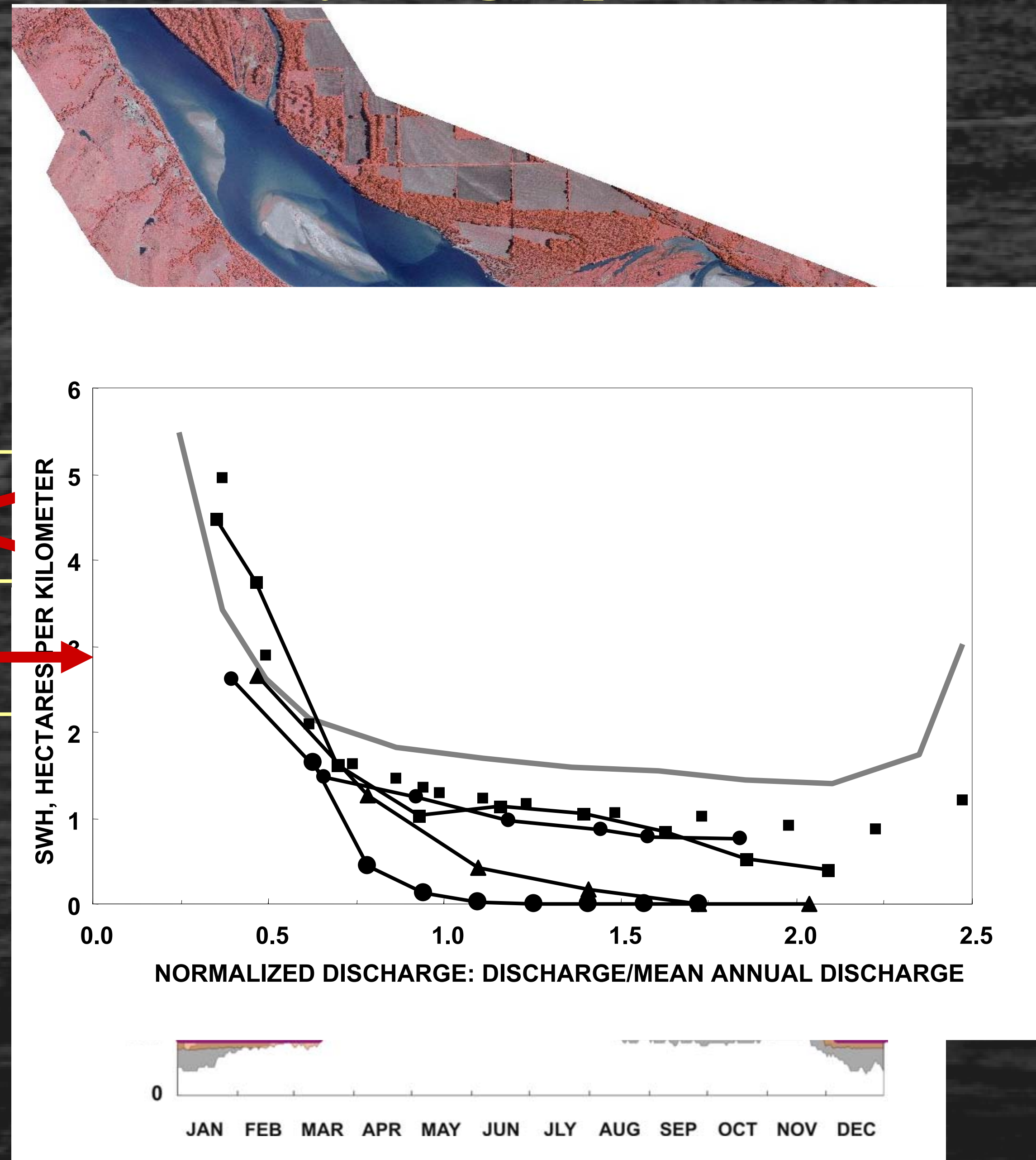
Spring Rise:

Hypothesized Role

Build sand bars

Connect flood plain

Spawning cue



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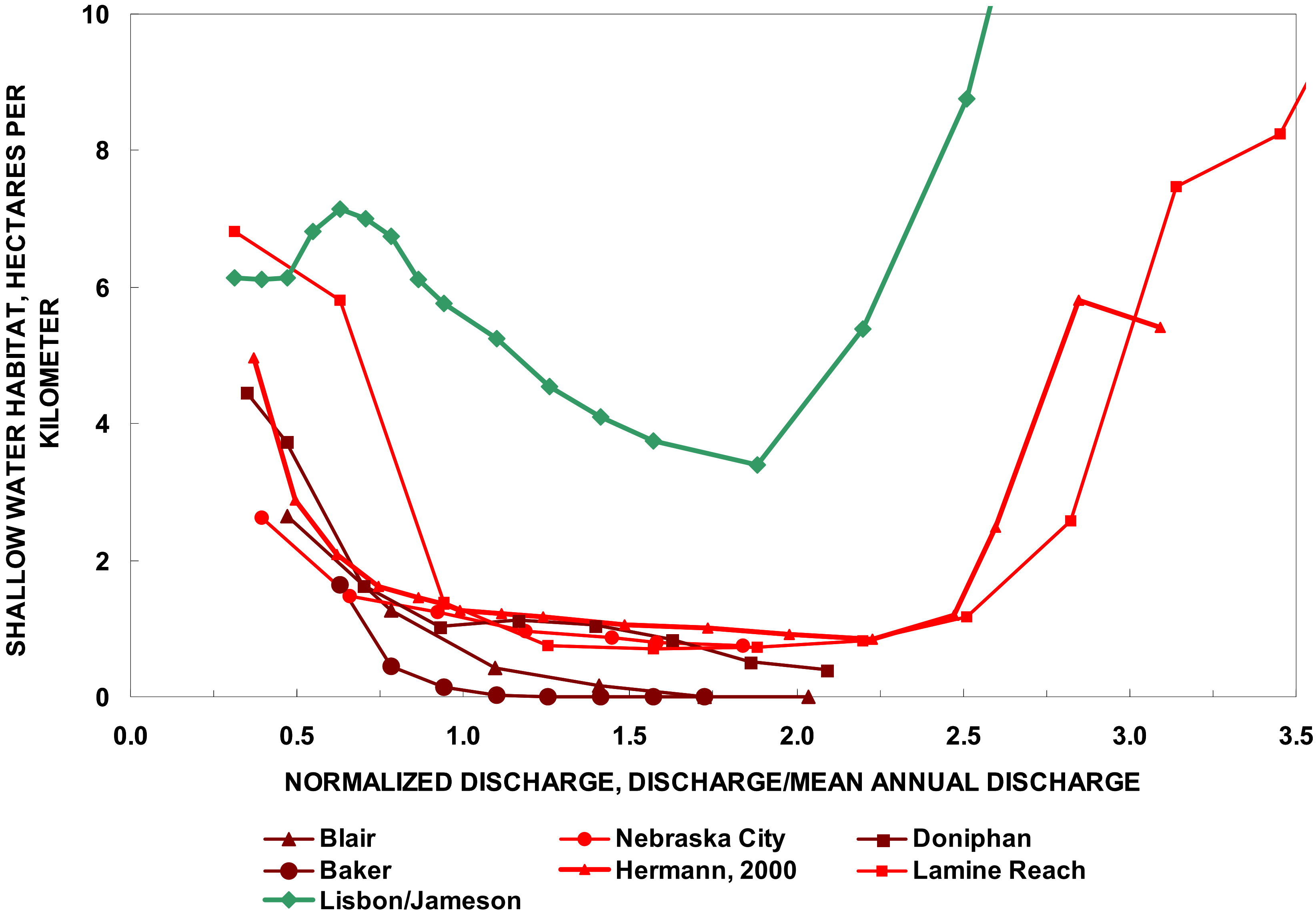
Functions of the Hydrograph - Connectivity



Functions of the Hydrograph

Spring Rise:

Hypothesized Role
Build sand bars
Connect flood plain
Spawning cue

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Engineering the Hydrograph

Two approaches to designing hydrograph attributes:

- *Specific biological information*
- *Historical hydrograph*

Use sparse biologic data to constrain design; then use reference hydrograph to define range of flows characteristics.

Tools:

- *Daily routing model for hydrologic scenarios*
- *Hydrograph analysis – IHA approach*

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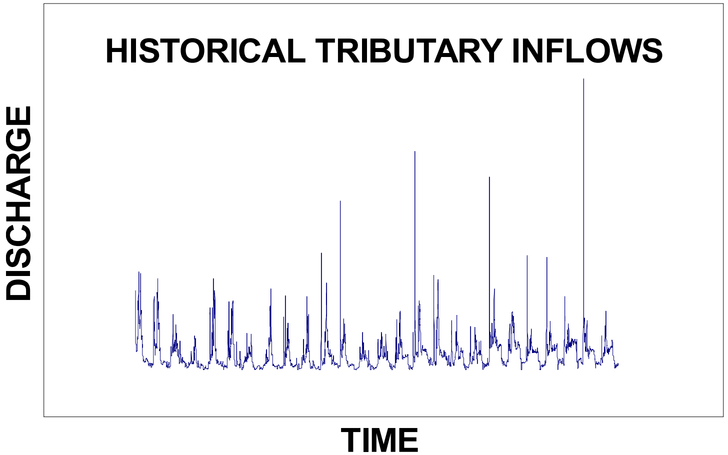
Hydrologic Scenarios

USACE Daily Routing Model

- *100 years of daily data, entire basin*
- *Routed to downstream gage sites*
- *Standard of analysis for Missouri River*

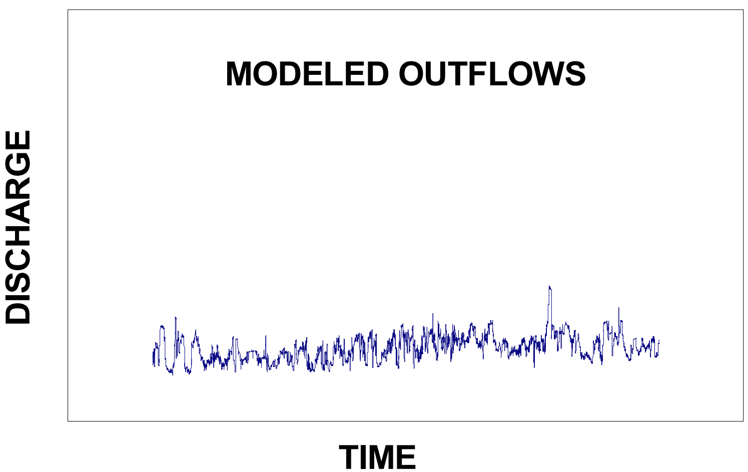
Critical for analysis and management; not easily used by stakeholders

Corps of Engineers Missouri River Daily Routing Model*



COE DAILY ROUTING MODEL

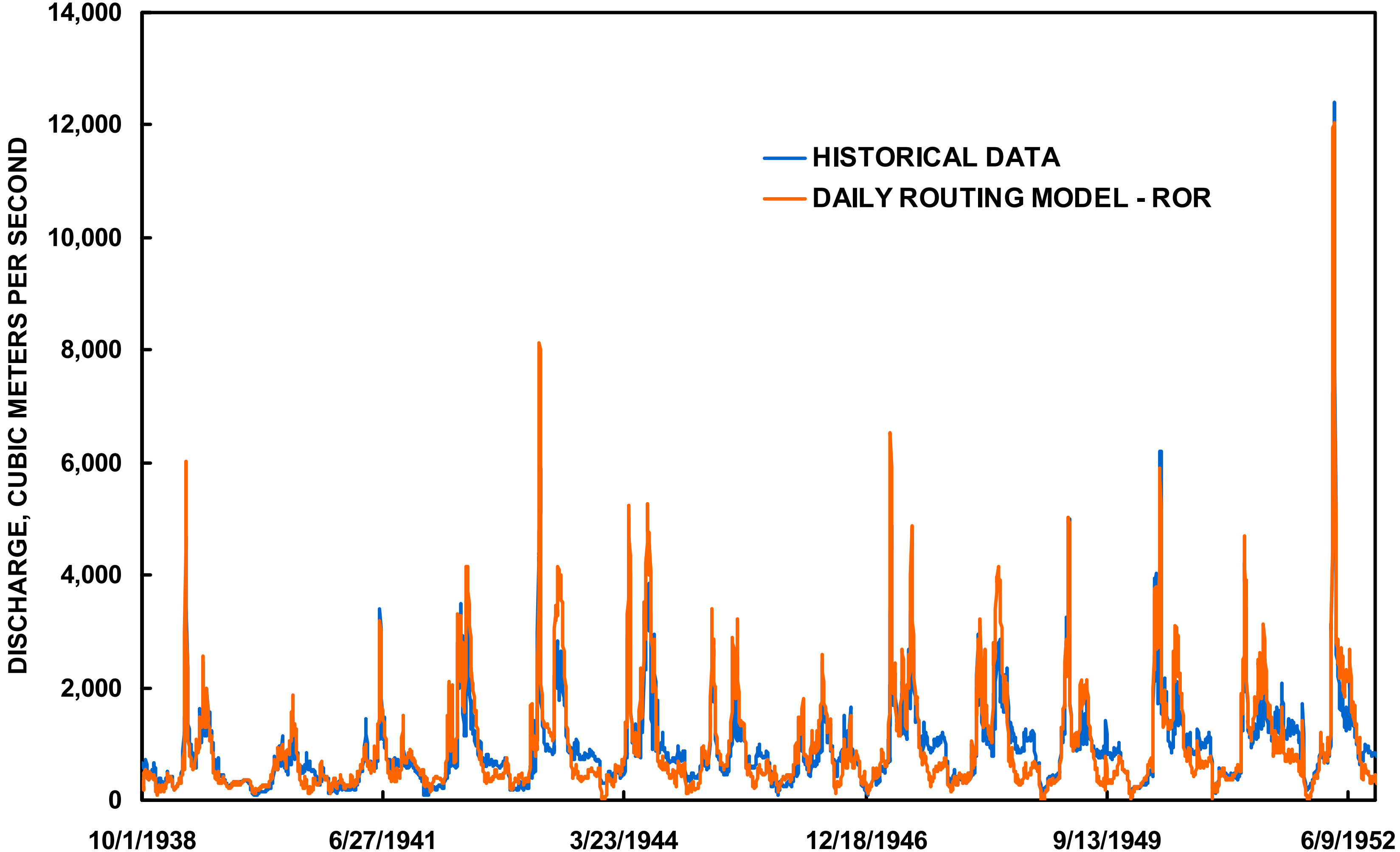
WATER-CONTROL RULES:
HYDROPOWER PRODUCTION
FLOOD CONTROL
RESERVOIR UNBALANCING
DROUGHT CONSERVATION
NAVIGATION
THREATENED, ENDANGERED SPECIES
...



COE EFFECTS MODELS

BENEFITS:
HYDROPOWER
FLOOD CONTROL
WATER SUPPLY
IRRIGATION
NAVIGATION
RECREATION
THREATENED, ENDANGERED SPECIES
...

*** Roy McAllister, COE**



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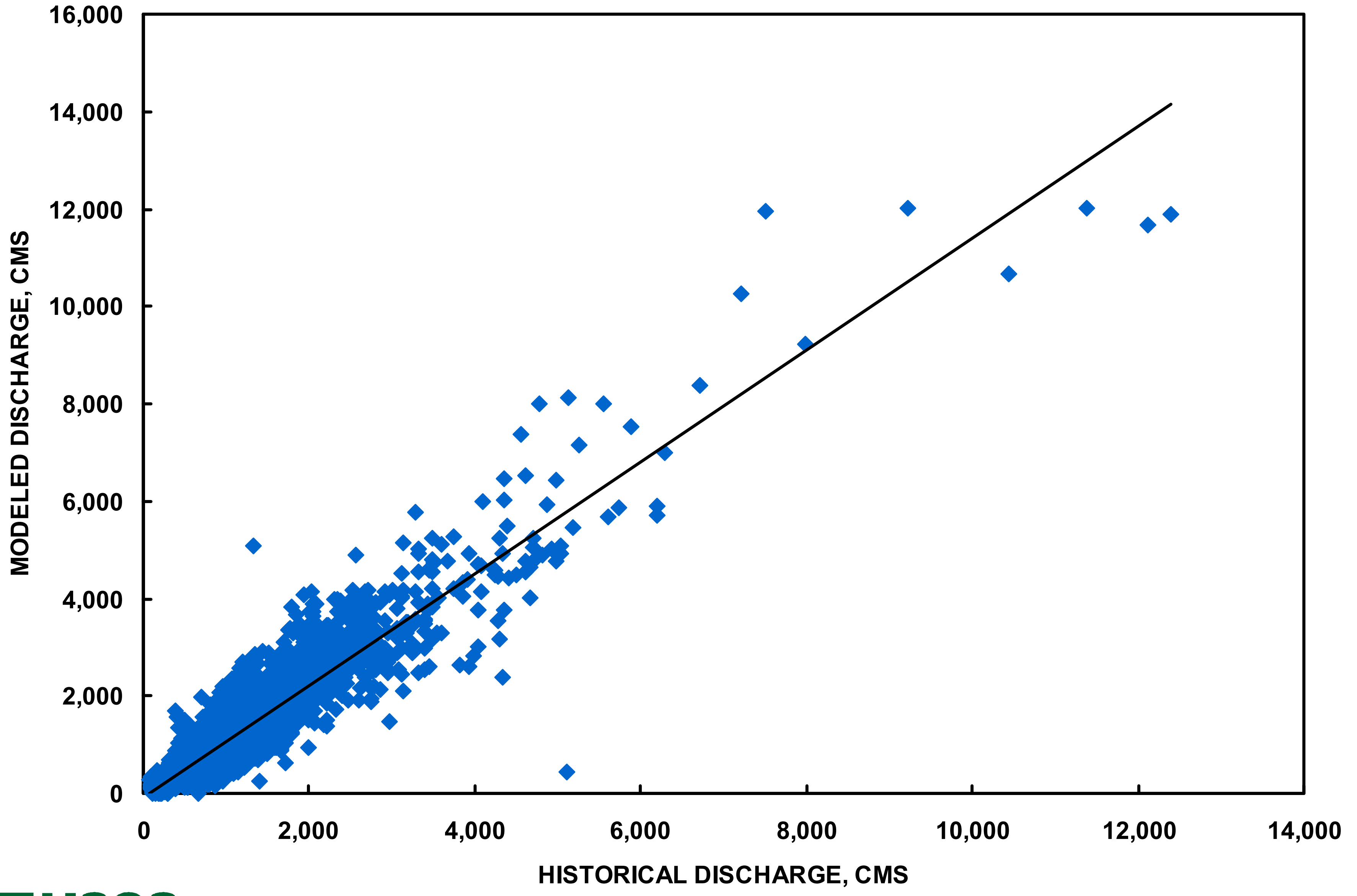
science for a changing world



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science for a changing world

DRM Model Performance

Nash-Sutcliffe model efficiency (Nash and Sutcliffe, 1970). Analogous to R2 in linear regression; a common measure of model performance in hydrologic modeling

Compared ROR model results to historic USGS records for WY1929-1948.

- *Model efficiency @ Sioux City: 0.71*

Compared CWCP model results to historic records for WY1967-1997

- *Model efficiency @ Sioux City: 0.83*

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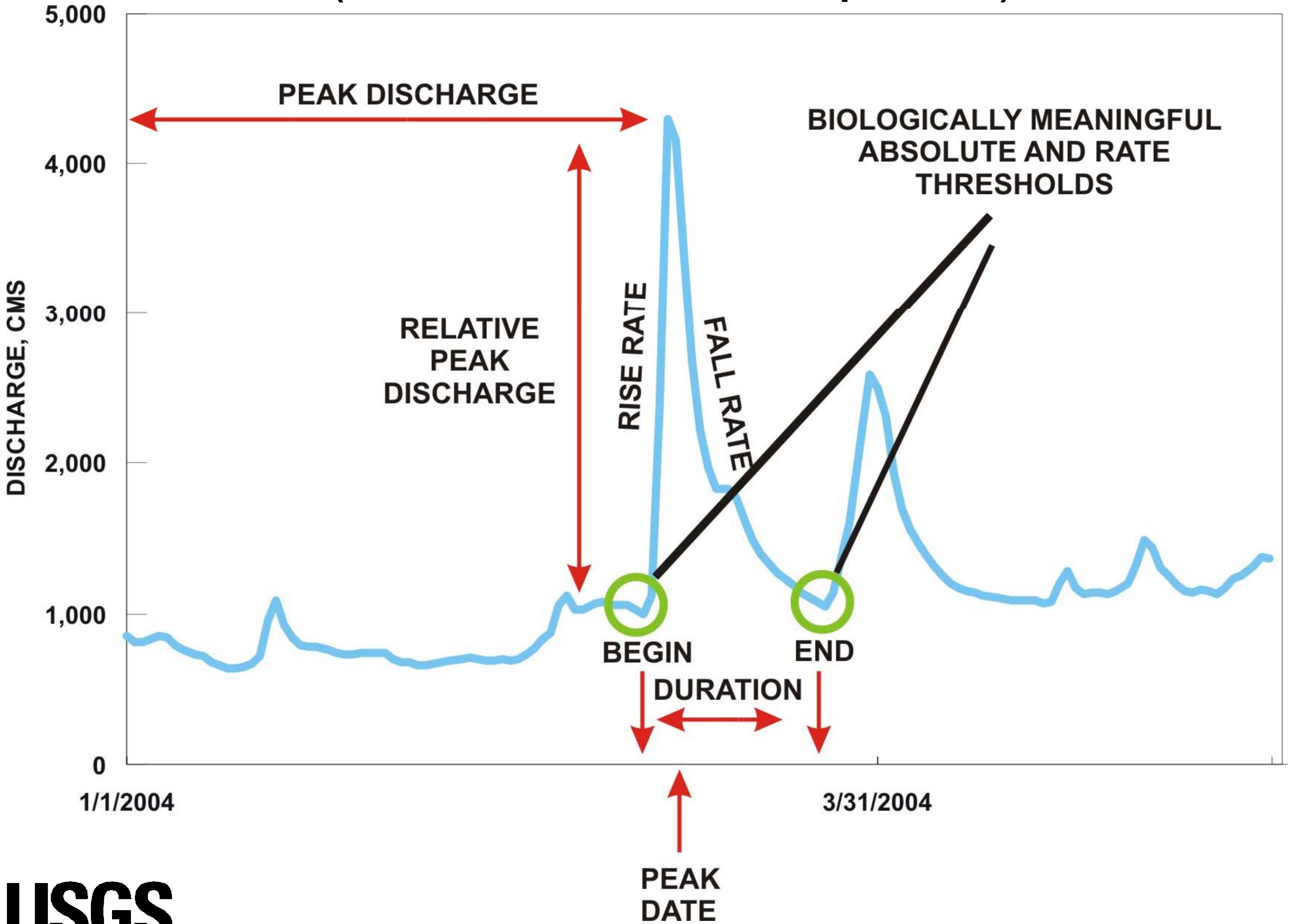
Parsing the Hydrograph for Ecological Meaning

(Environmental Flow Components)



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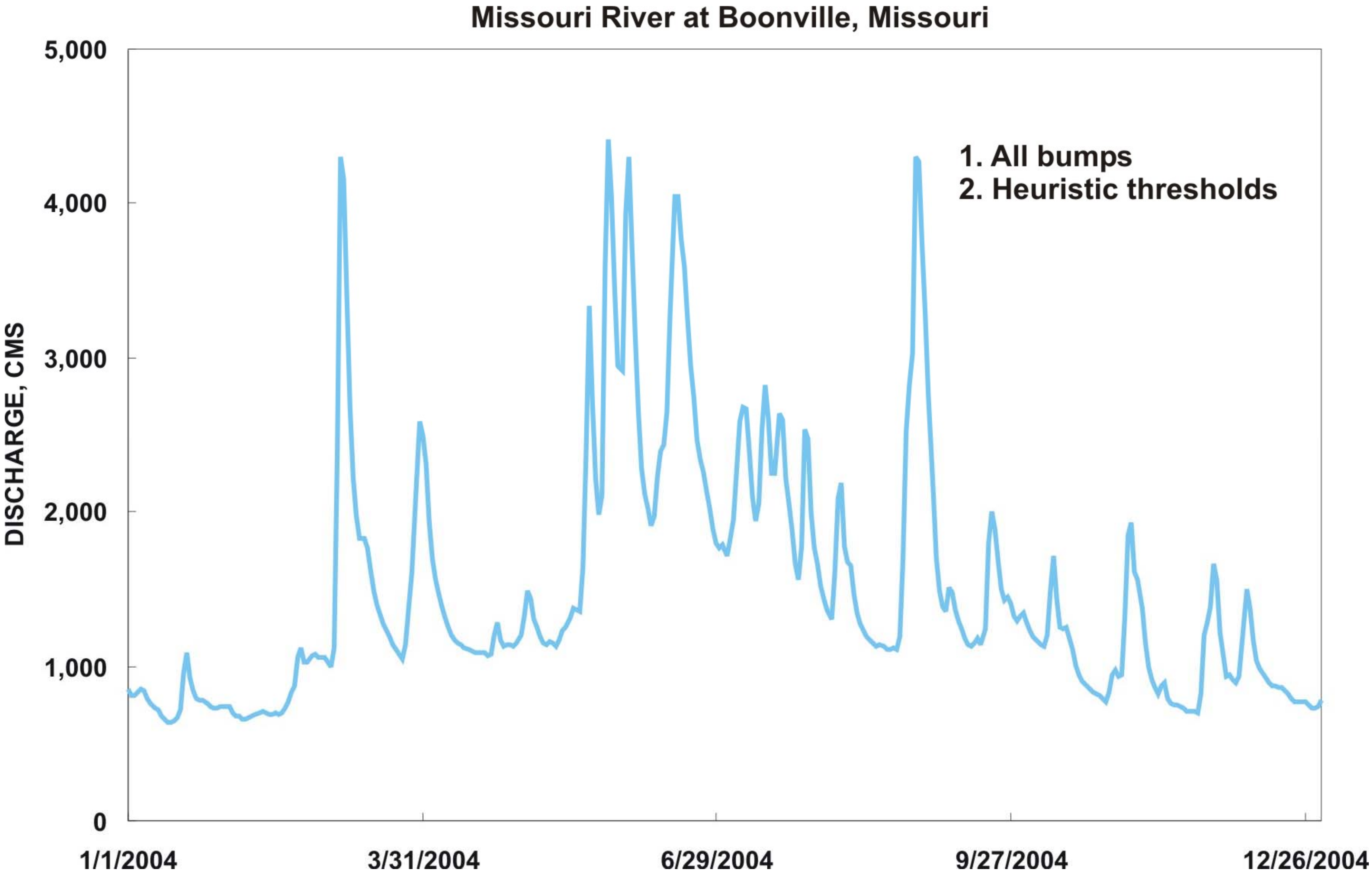
Parsing the Hydrograph



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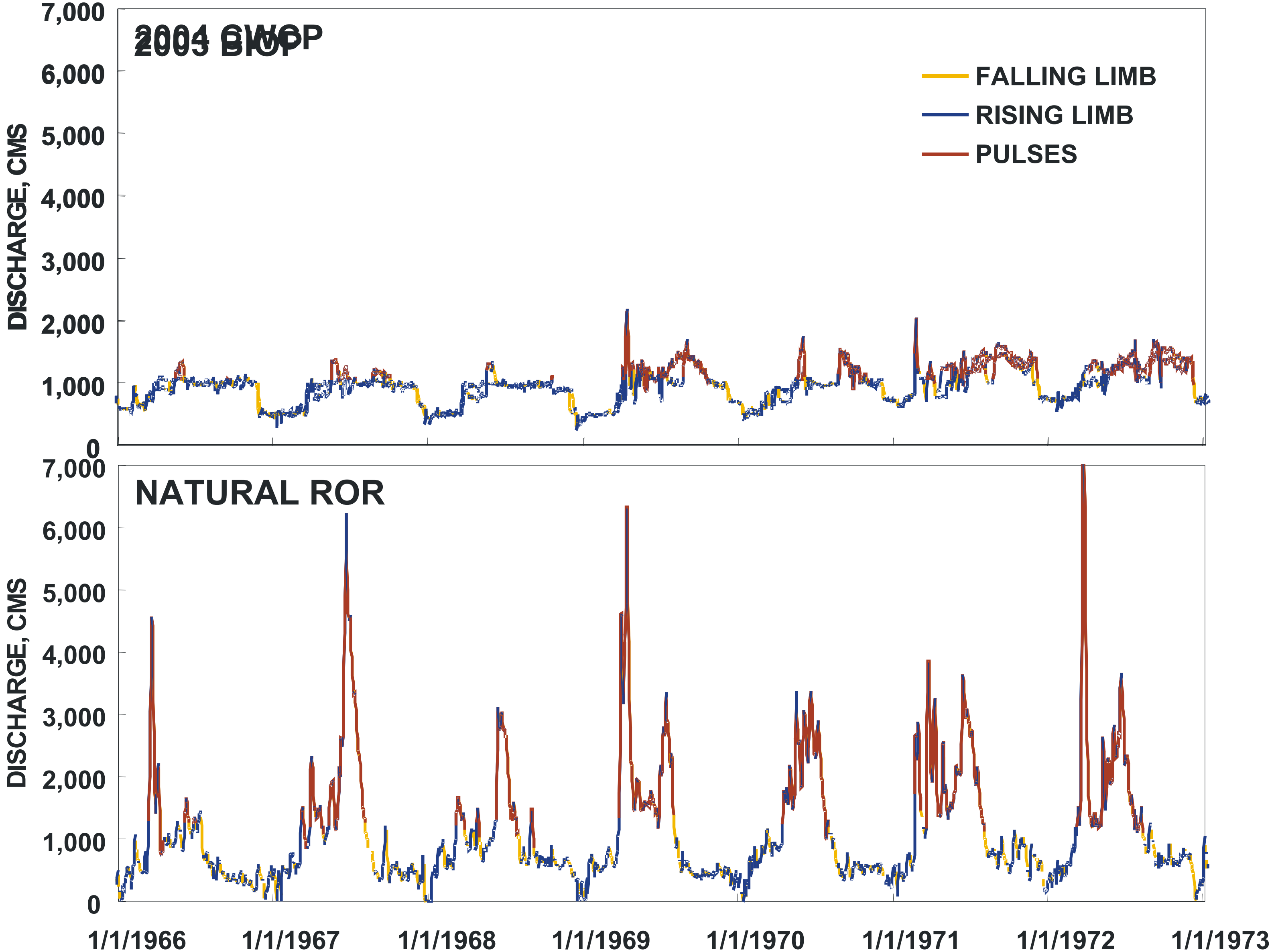
Lower Missouri Flow-Regime



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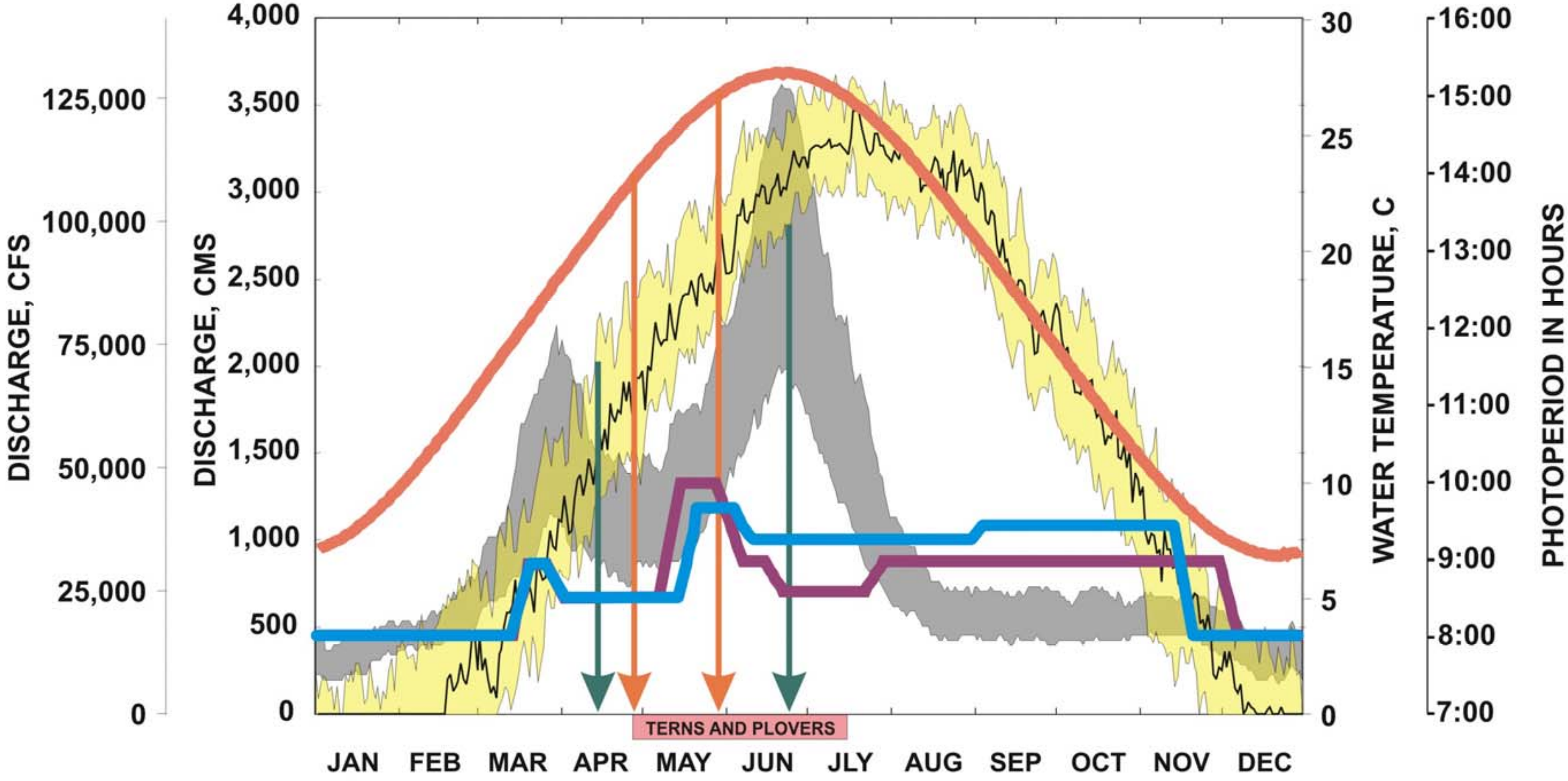
Estimates of Sturgeon Spawning Window



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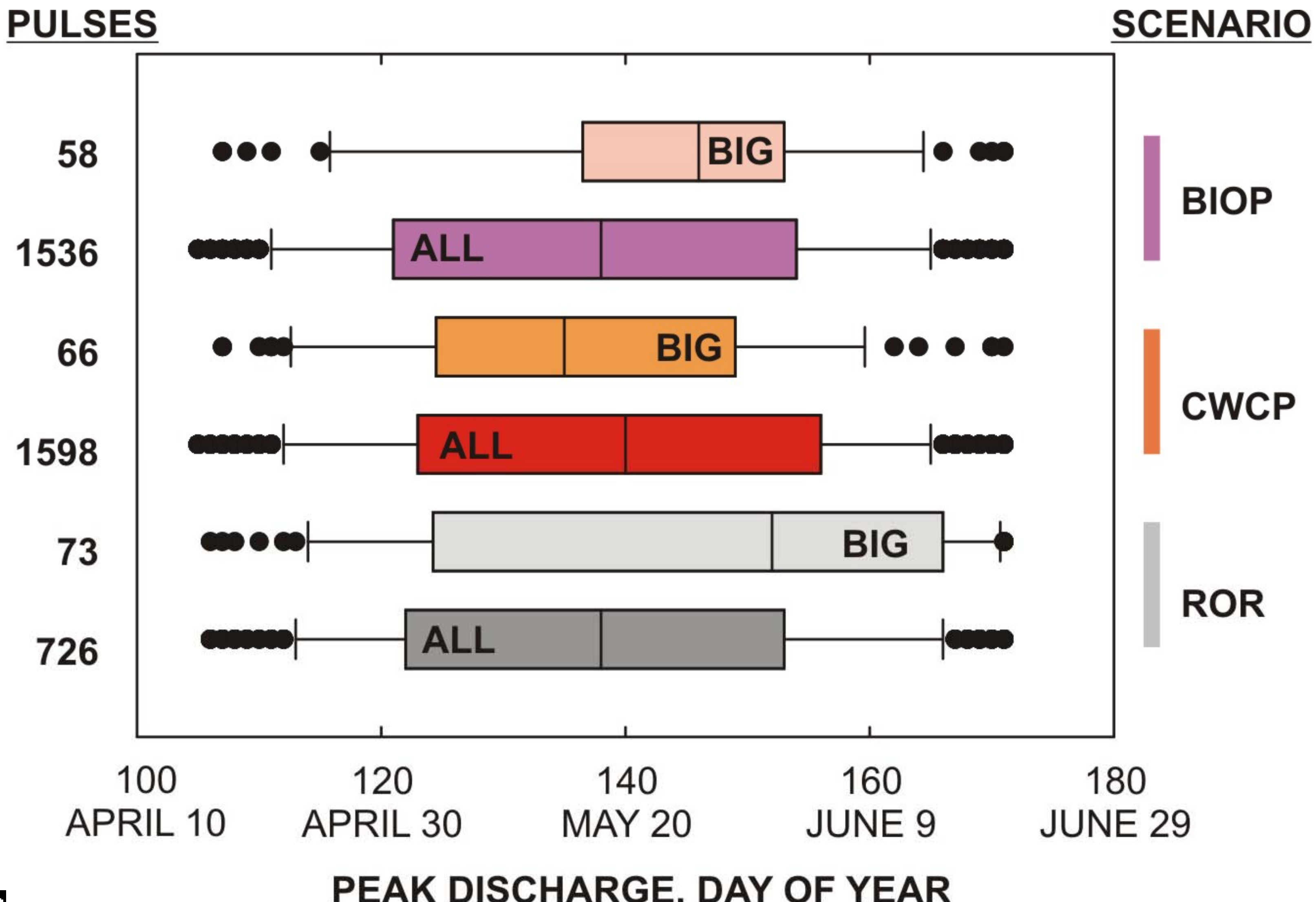
Pulse Properties in Spawning Window



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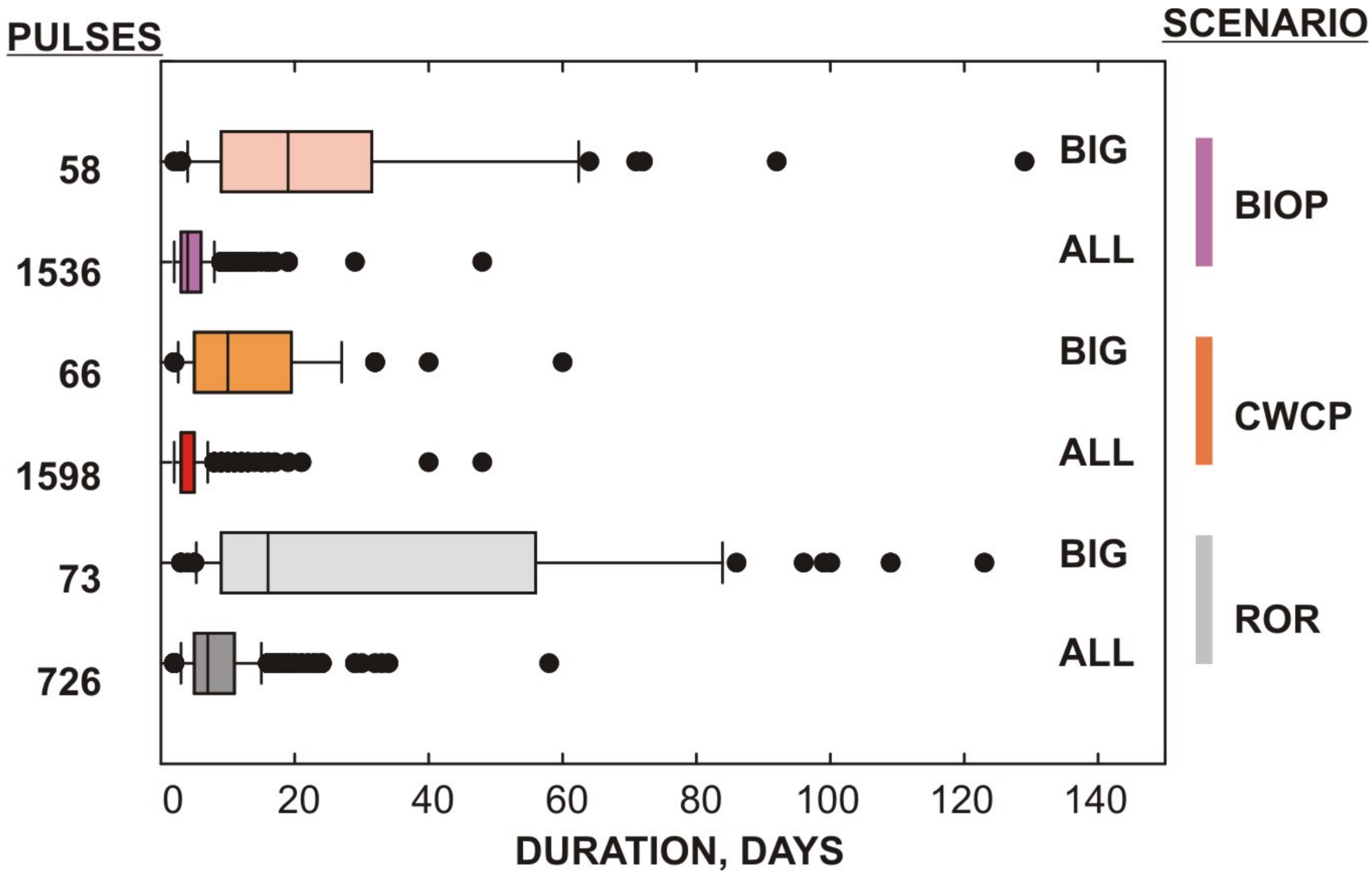
Pulse Properties in Spawning Window



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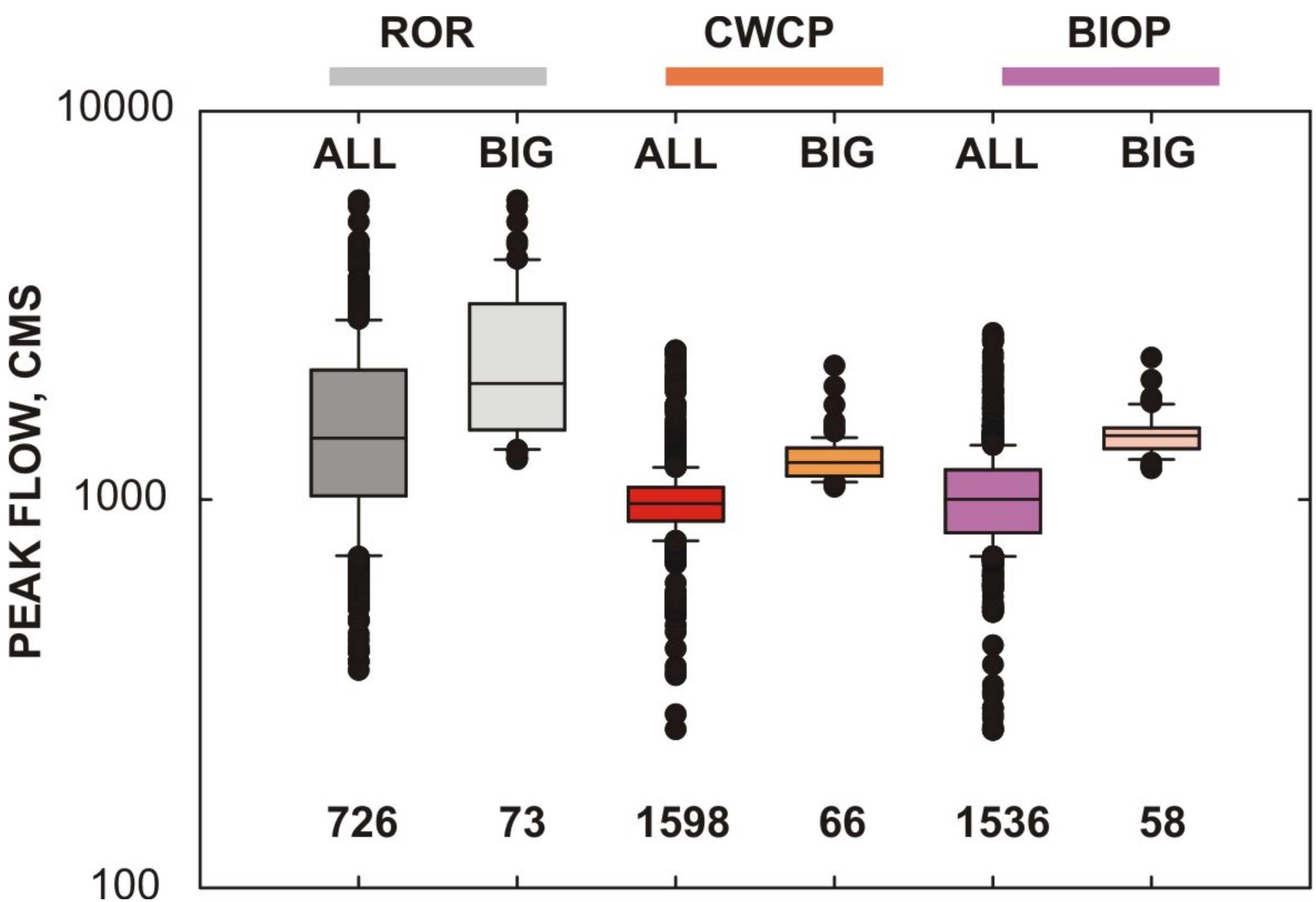
Pulse Properties in Spawning Window



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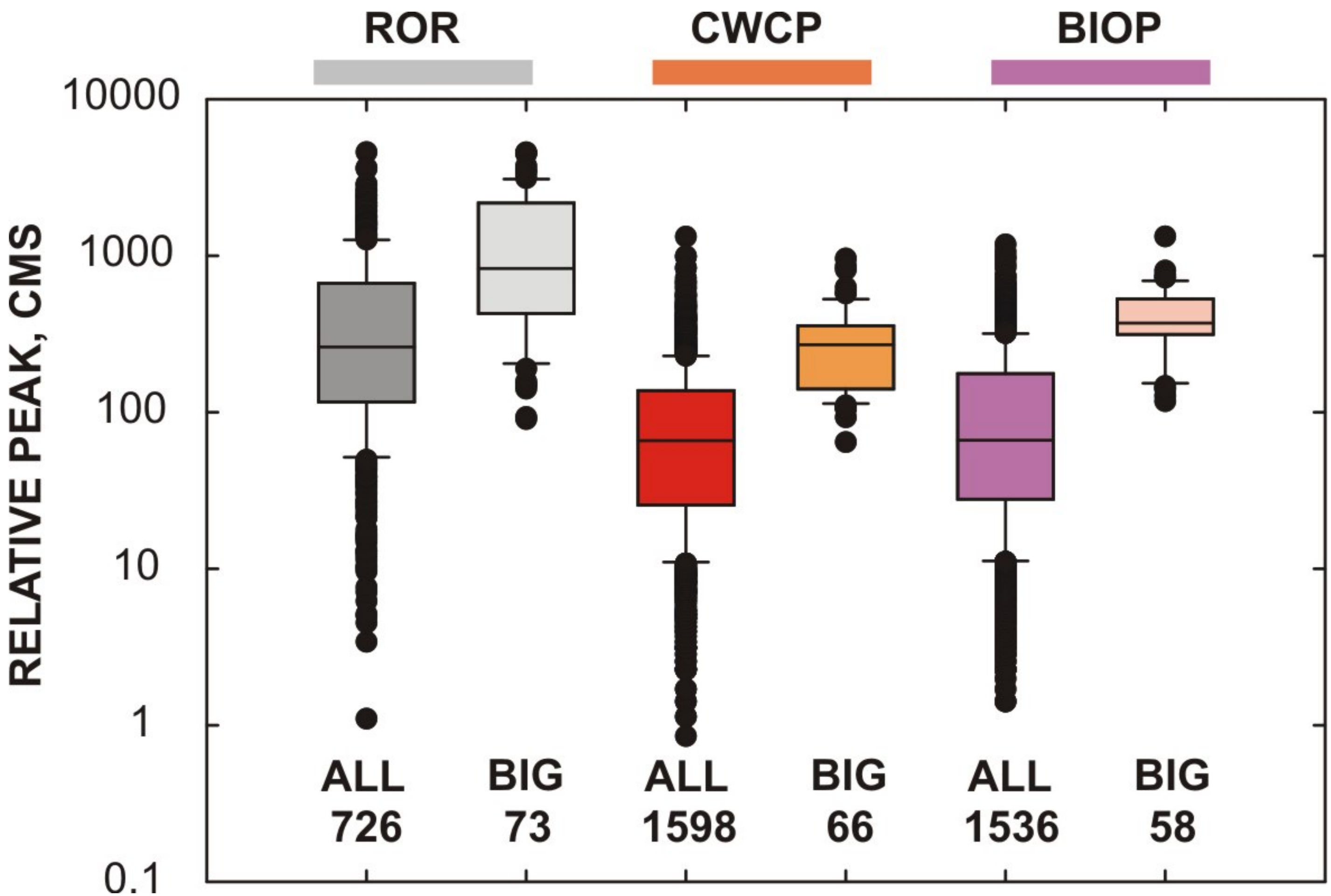
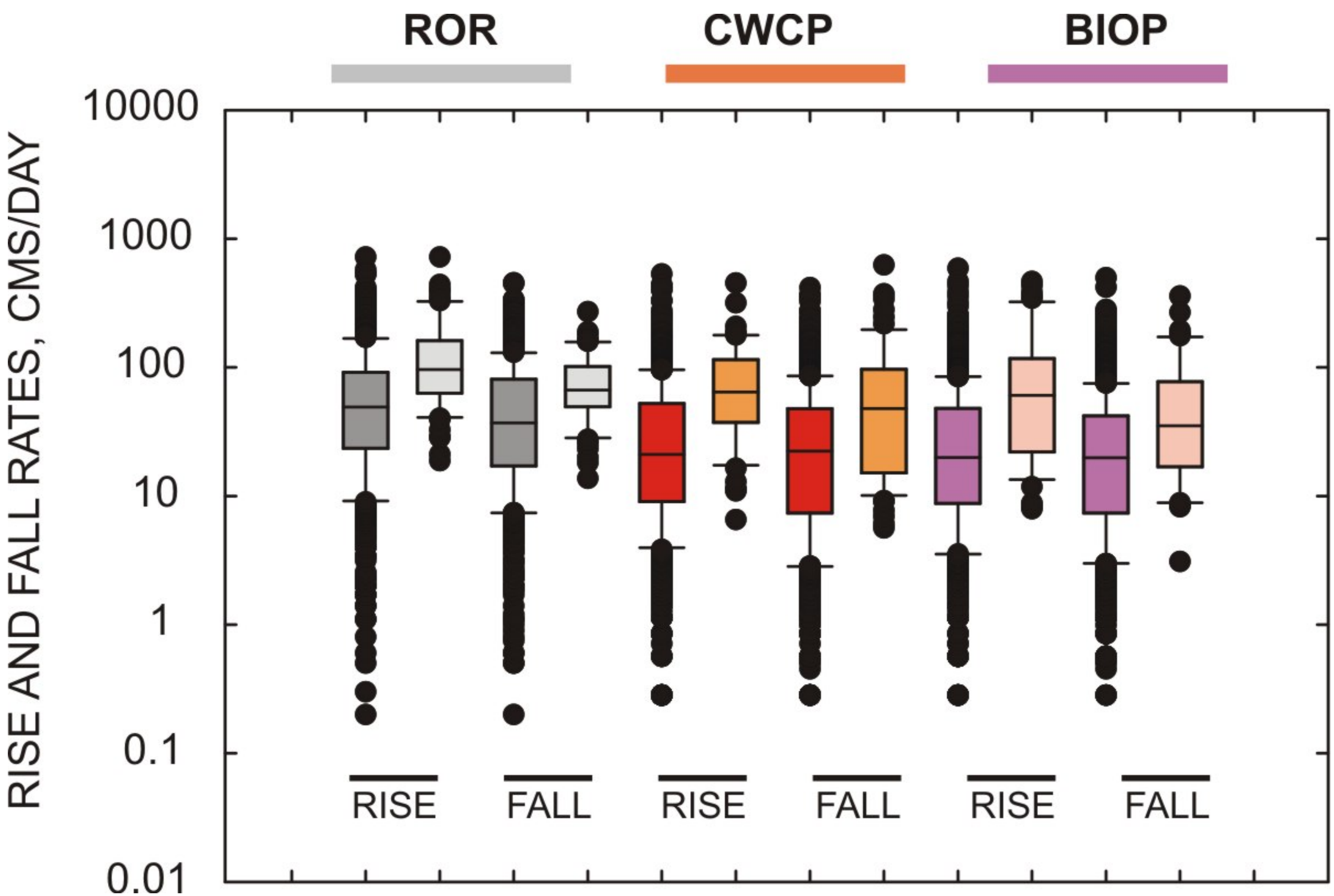
Pulse Properties in Spawning Window



Pulse Properties in Spawning Window



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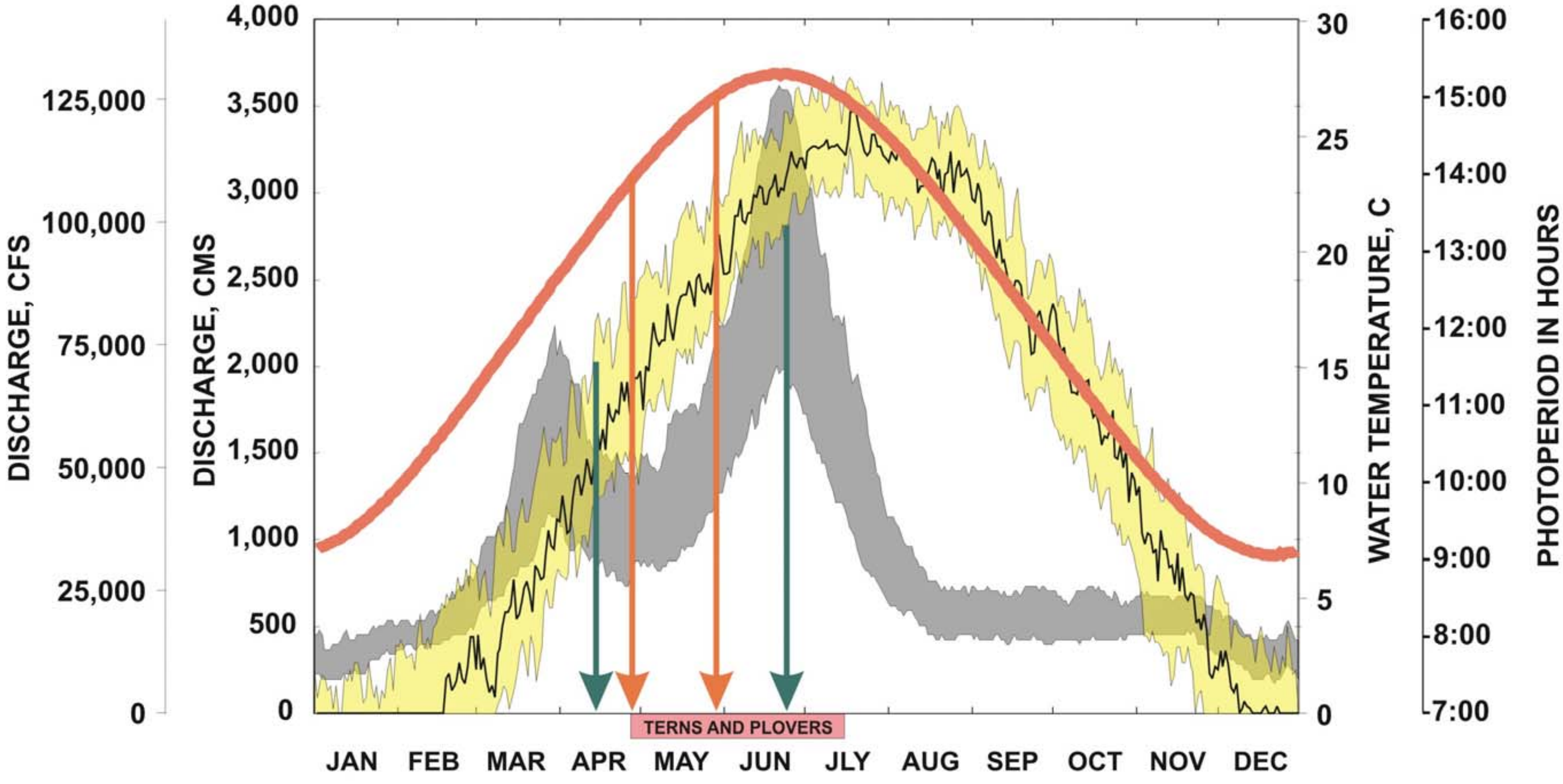
Generic Design: Bio Constraints & Natural Hydrograph



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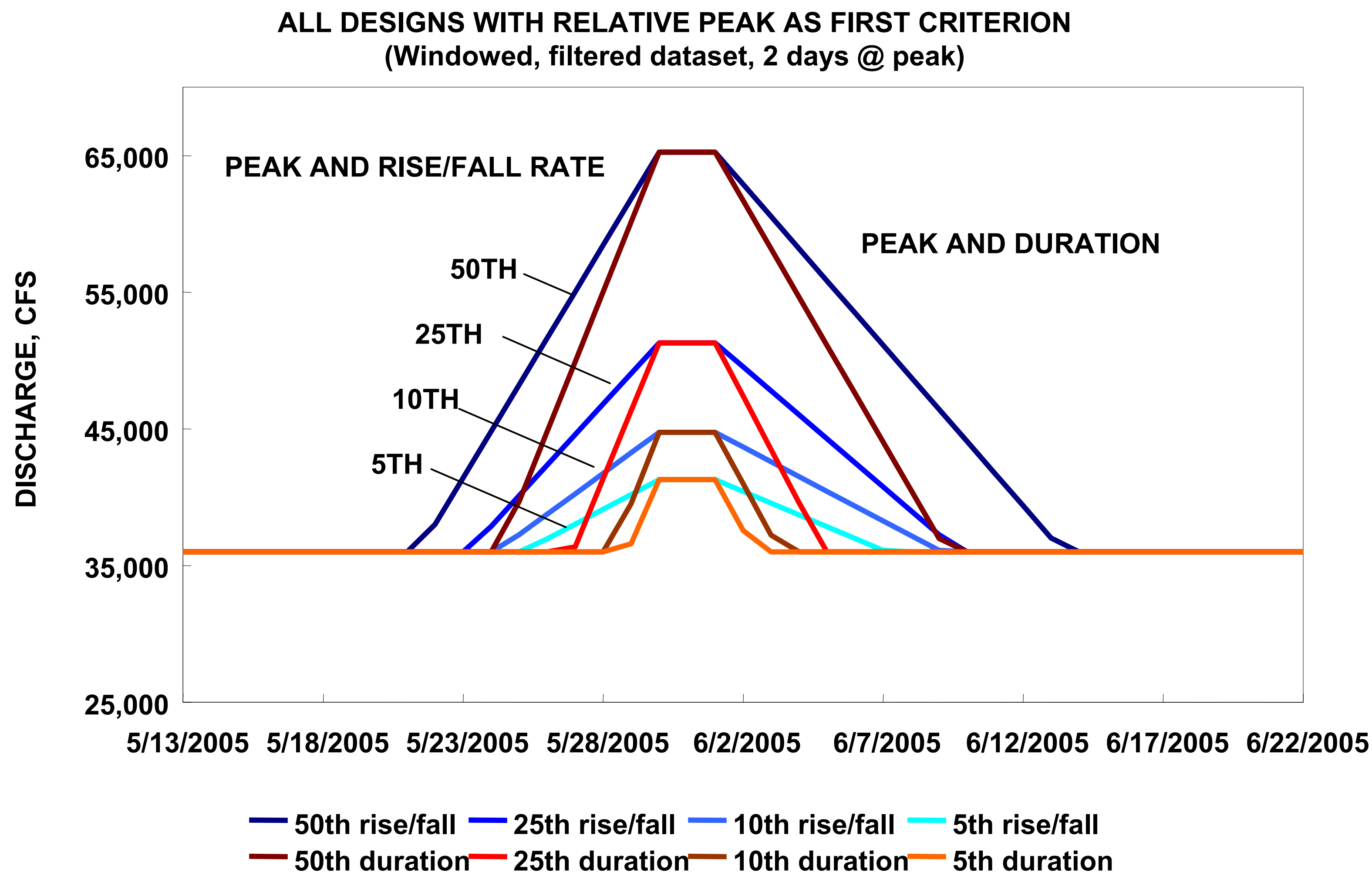
Key Biological Questions

- *Windows:*
  - *Tighter?*
  - *Sequence: cue (flow + T)?*
    - *Pulse occurs in T window*
  - *Or: cue (flow) – migrate – spawn (T)?*
    - *How long/far for migrate – stage cue?*
    - *Pulse occurs n days before T window*
- *Thresholds: begin and end of pulse*
  - *What does the fish feel?*

Design Based on ROR Hydrograph



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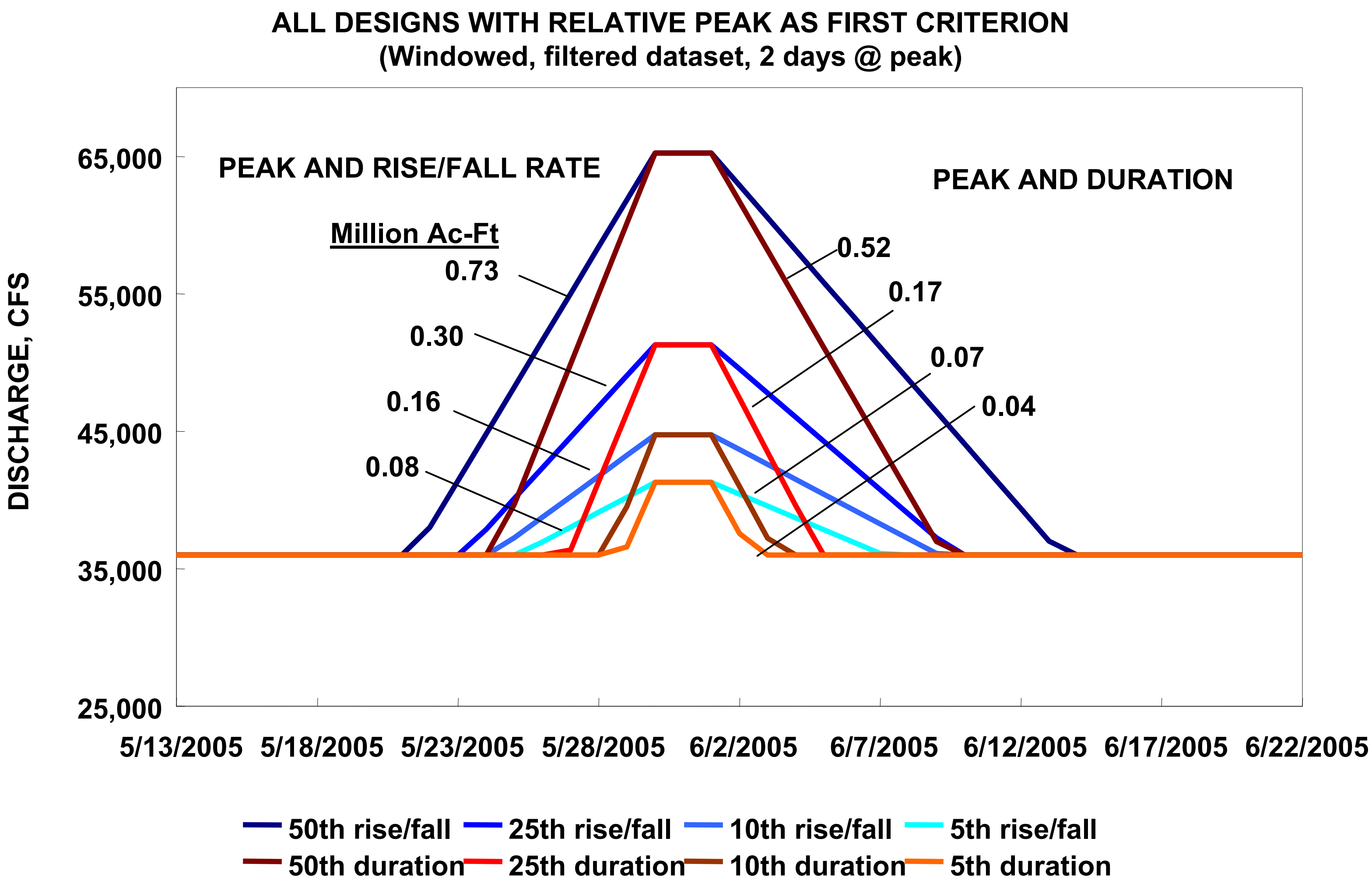
Design Based on ROR Hydrograph



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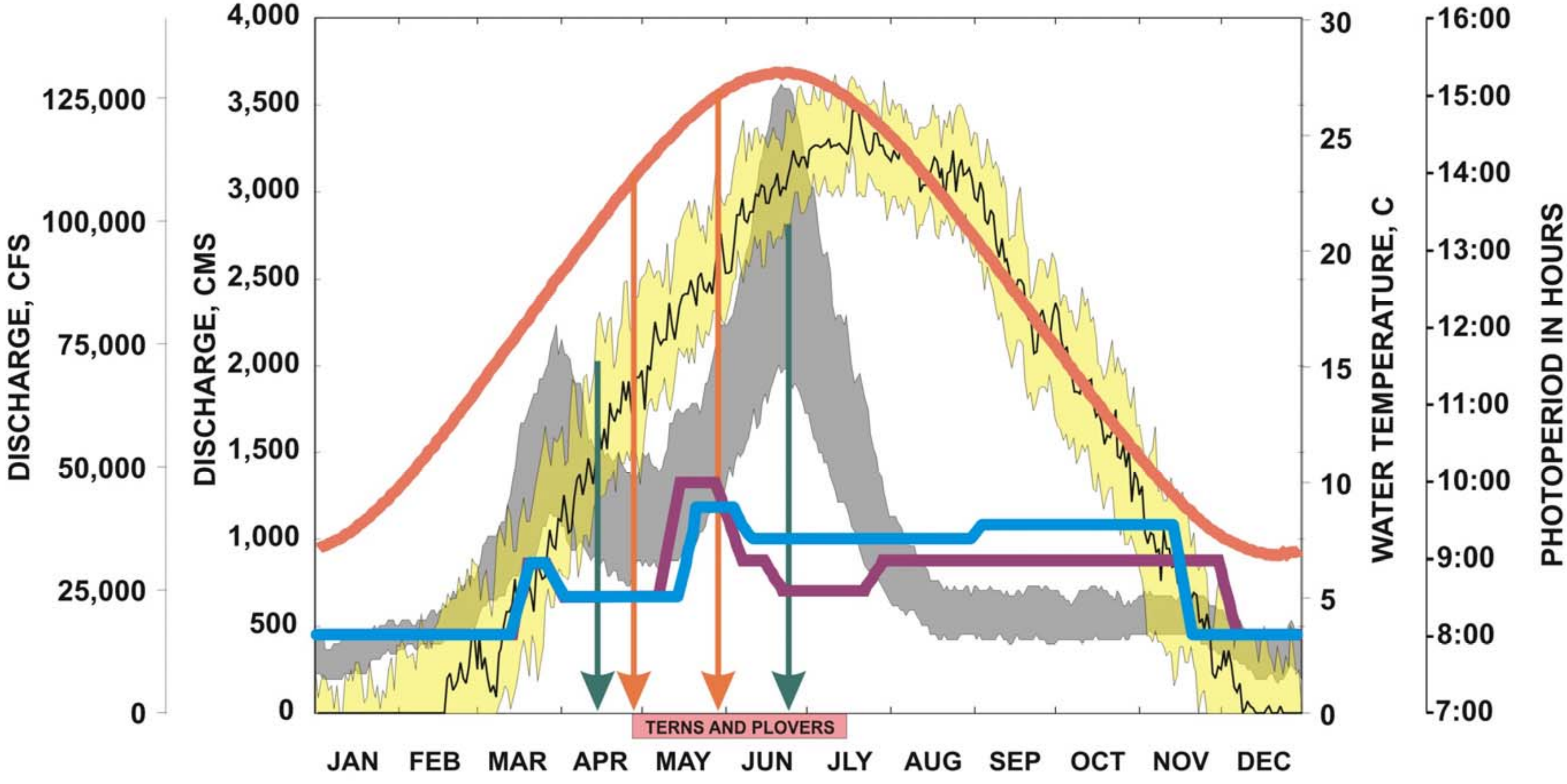
Estimates of Sturgeon Spawning Window



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